Working with Uncertainty in Sparse and Unreliable Data

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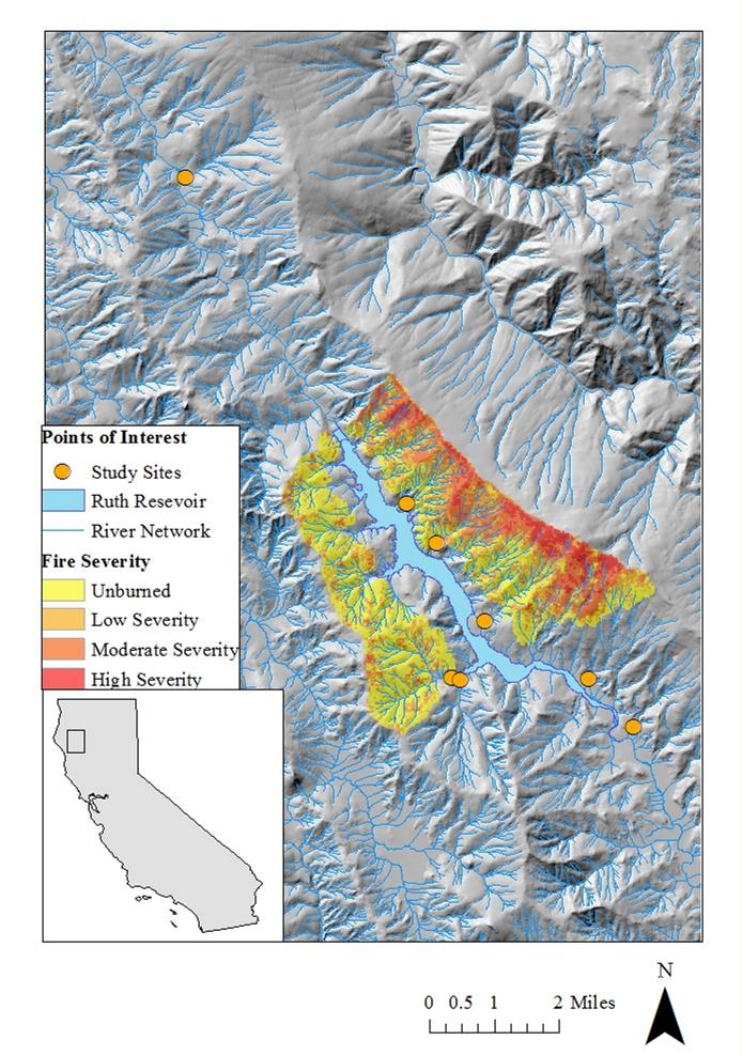
Outline

- Project Overview
- Original goals
- Data received
- Sediment discharge
- Gaussian Processes (GPs)
- Data inconsistencies
- Level of uncertainty
- Future methods

Project Overview



Hamilton, E., Buhr, D. (2016). *Untitled* [map]. Corvallis, OR

- Study site: Ruth Reservoir, Mad River, CA
- Affected by a wildfire in 2015
- 8 tributaries, burned to various degrees
- Studying the effect of fire disturbances on river networks

The Original Goal

- Expectation: increased sedimentation at burned sites[1] due to hydrological and geomorphological changes[2]
- Task: compare sediment yield between the eight tributaries

[1] Canfield, H., Goodrich, D.C., & Burns, S. (2008). Selection of parameters values to model post-fire runoff and sediment transport at the watershed scale in southwestern forests. *Managing Watersheds for Human and Natural Impacts*: pp. 1-12. [**doi**: 10.1061/40763(178)48].

[2] Shakesby, R.A. & Doerr,S.H. (2006). Wildfire as a hydrological and geomorphological agent. *Earth-Sci. Rev.*, 74:269-307. [**doi**:10.1016/j.earscirev.2005.10.006].

Data Received

Six trips from January - May provided the following:

- Field notes
- Culvert Measurements
- Sampler Measurements
- Photos

We also used USGS stream gage data.

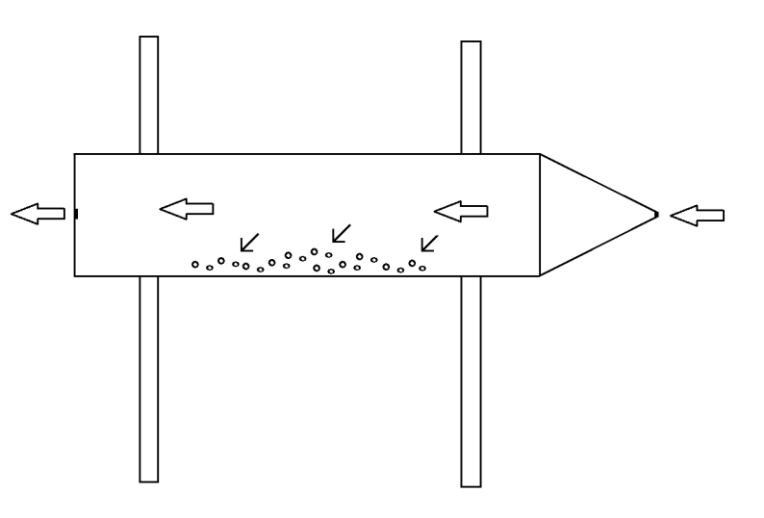
Culvert Measurements

Measurements needed to calculate discharge:

- Culvert diameter
- Water depth
- Culvert slope
- Manning’s roughness

Sampler Measurements

Sediment Mass: Phillip's Sampler



Sampler Measurements

Sediment Concentration: ISCO & Grab Samples

Google images, https://www.agry.purdue.edu/water/fieldstn/photogallery/WQFSphotos.htm

Daily Sediment Discharge Records (the basics)

- There is an empirical and temporal relation between sediment discharge and water discharge[1]

[1] Porterfield, G. (1972). Computation of fluvial-sediment discharge. *US Geological Survey Techniques of Water-Resources Investigations*, Book 3. Chapter C3: 1–66.

Sediment Discharge

- $Q_s = CQ_wK$
  - Q_s= Sediment Discharge (tons/day)
  - C = Suspended-Sediment Concentration (g/ml)
  - Q_w = Water Discharge (ft^3/s)
  - K = Coefficient based on units of Water Discharge and specific weight of 2.65 for sediment[1]

[1] Porterfield, G. (1972). Computation of fluvial-sediment discharge. *US Geological Survey Techniques of Water-Resources Investigations*, Book 3. Chapter C3: 1–66.

Sediment Rating Curve (SRC)

SRC to Estimate Daily Discharge Records

- Power Function:
  - $Q_s = a(Q_w)^{\mathbf{b}}$
    - a = the intercept; and
    - b = the slope[1]
    - a and b both found by log-linear model
- Log-Linear Model
  - $\ln(Q_s) = \ln(a) + b\ln(\ln(Q_w) + \varepsilon$
  - $Q_s = \exp(a + b\ln(Q_w) + \varepsilon)$
    - ε = independent random variable $\sim N(0,\sigma^2)$

[1] Porterfield, G. (1972). Computation of fluvial-sediment discharge. *US Geological Survey Techniques of Water-Resources Investigations*, Book 3. Chapter C3: 1–66.

Graph of SRC

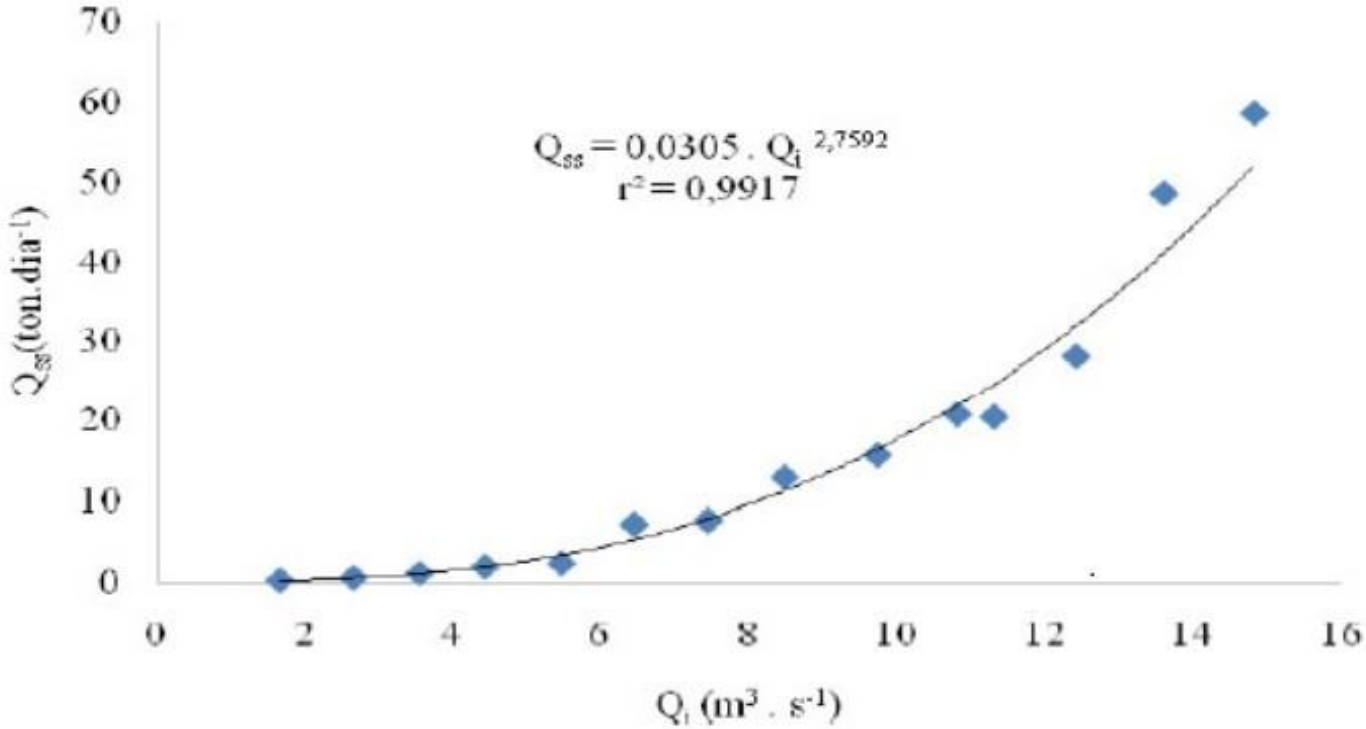
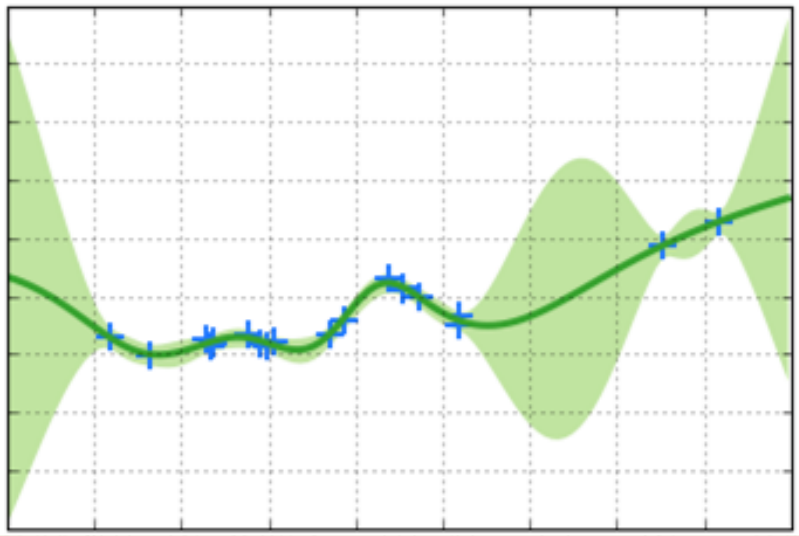


FIGURE 3. Sediment rating curve by the turbidimeter indirect method.

Google Image, http://www.scielo.br/img/revistas/eagri/v31n3/a19fig03.jpg

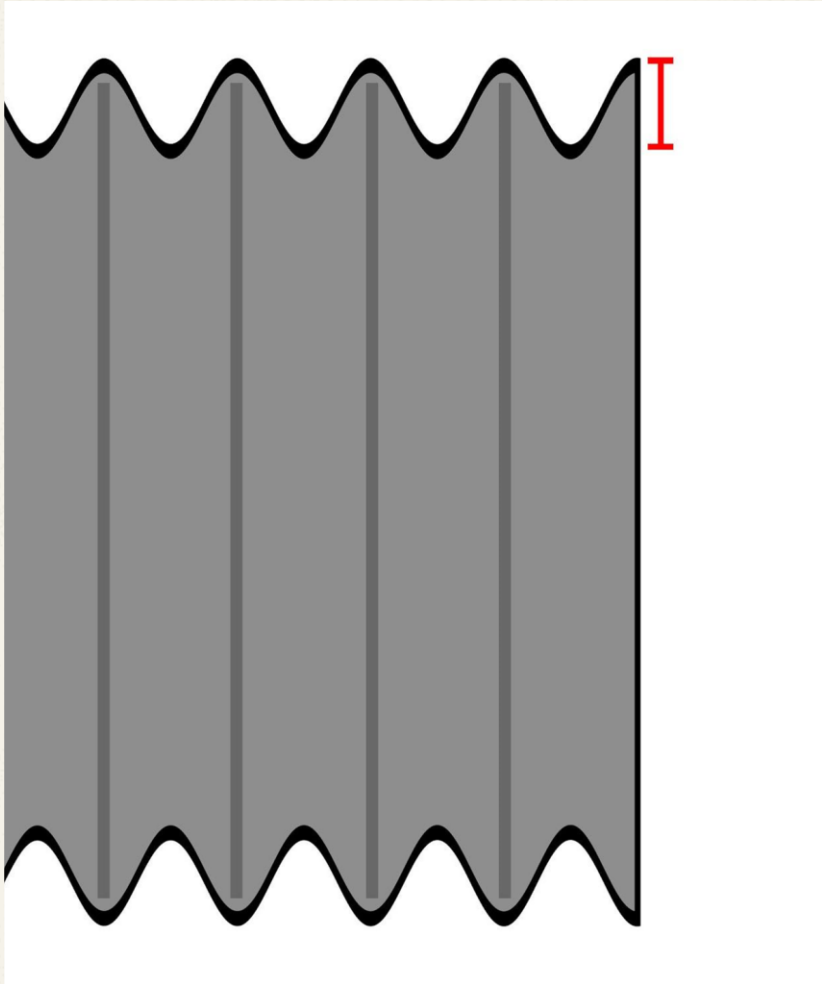
Gaussian Processes

- A supervised learning technique often used for regression
- A distribution of functions defined by a mean function and covariance function

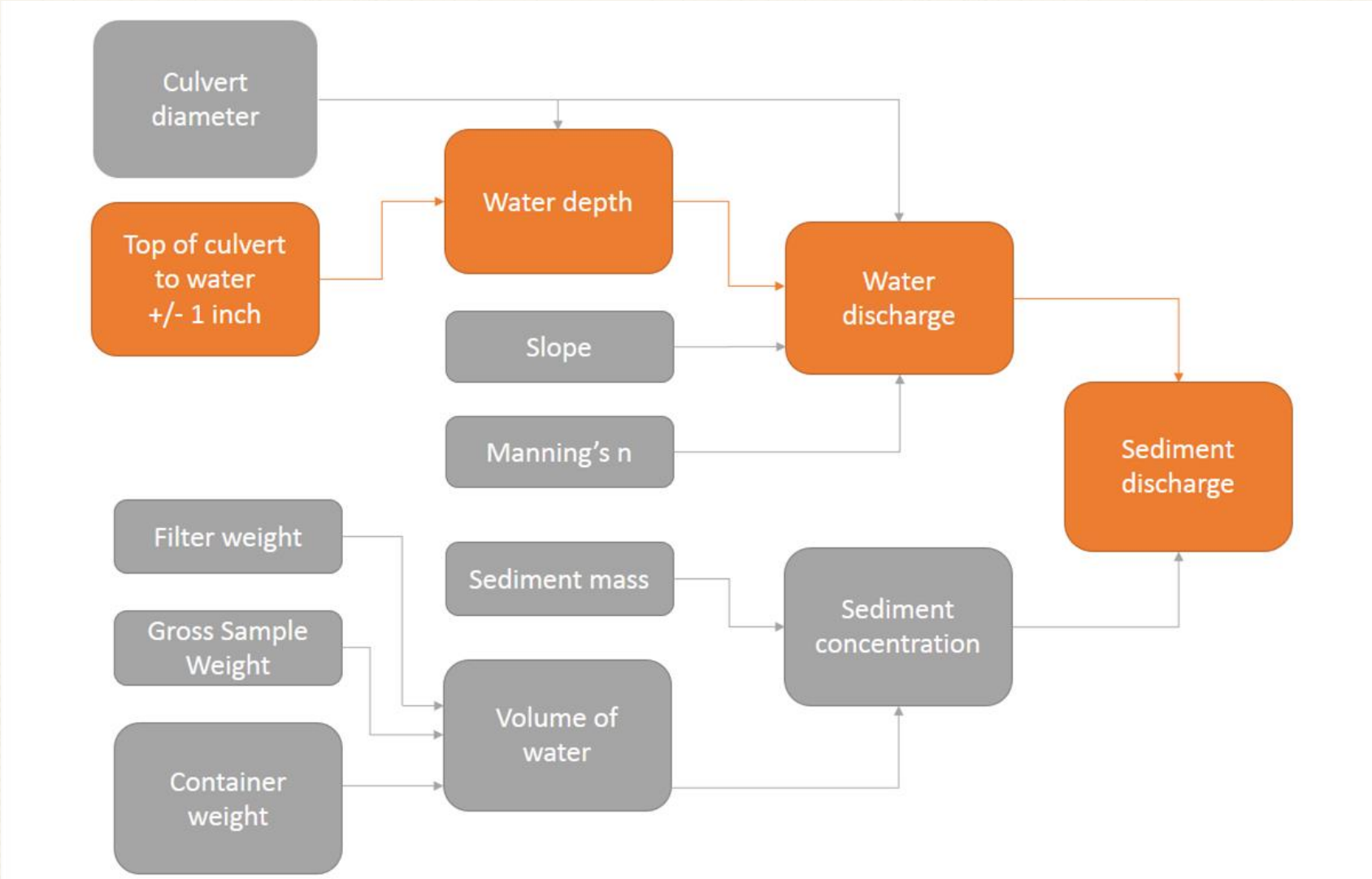


Inconsistencies

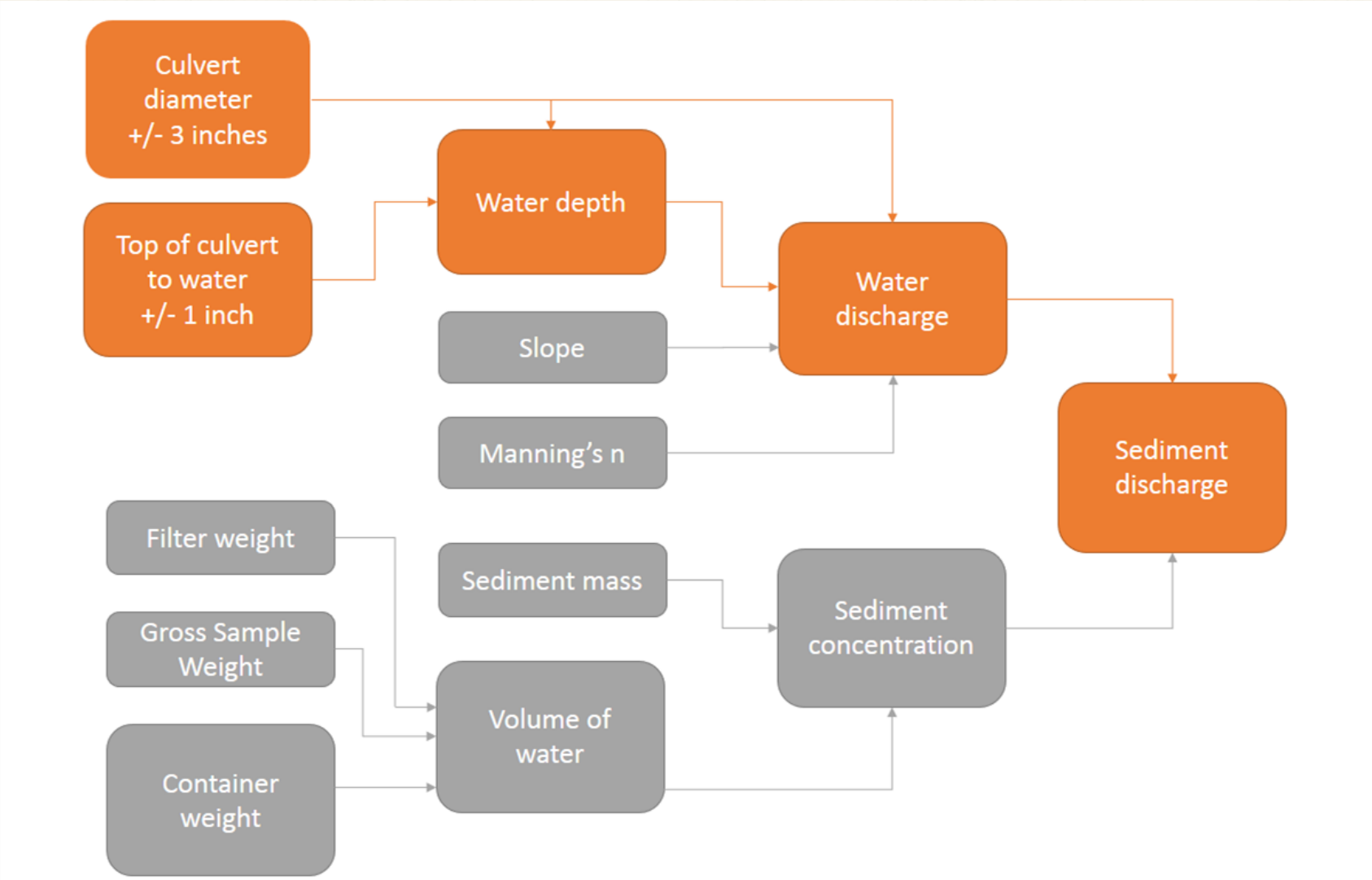
Water depth = 0



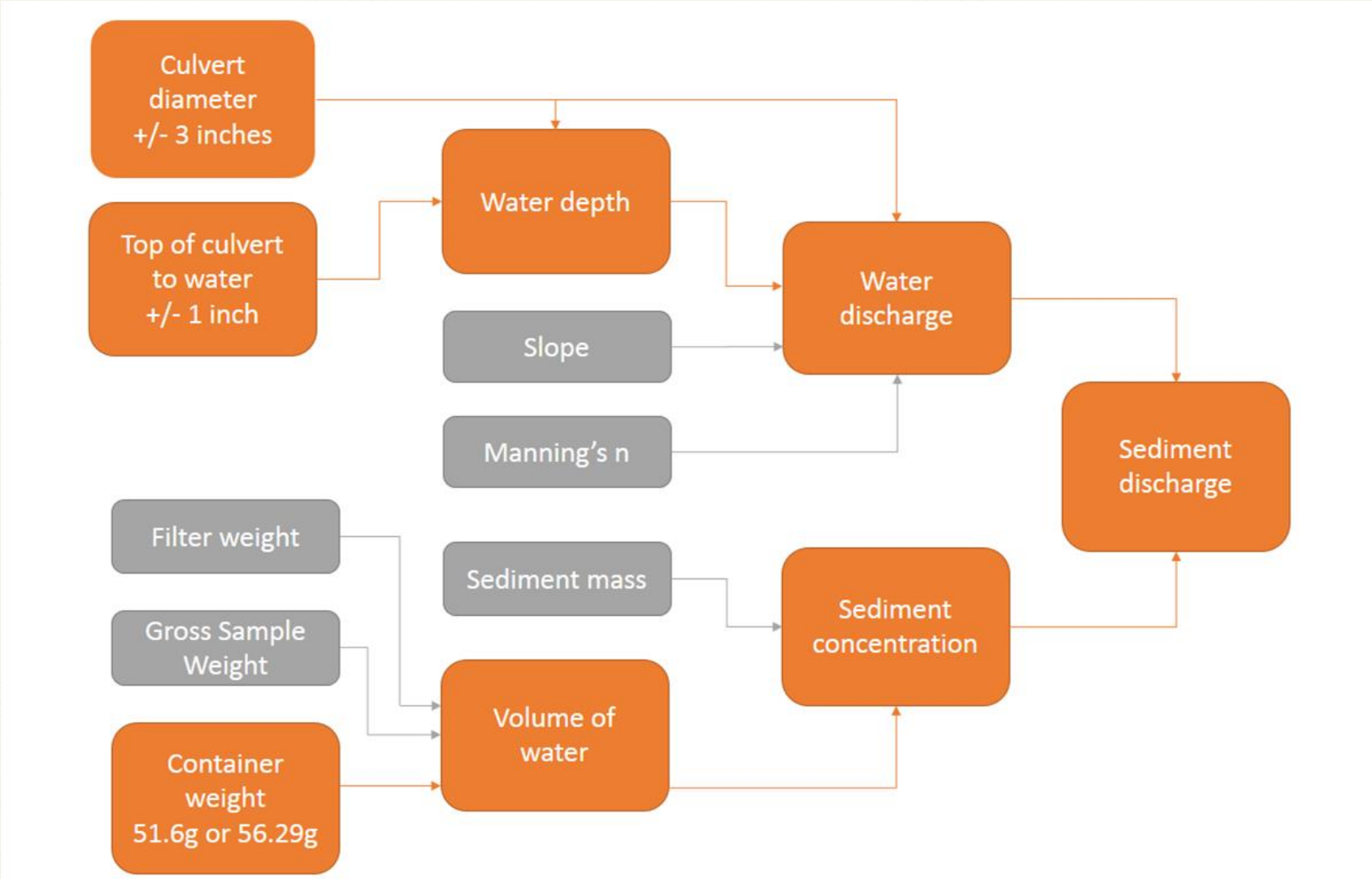
Level of uncertainty



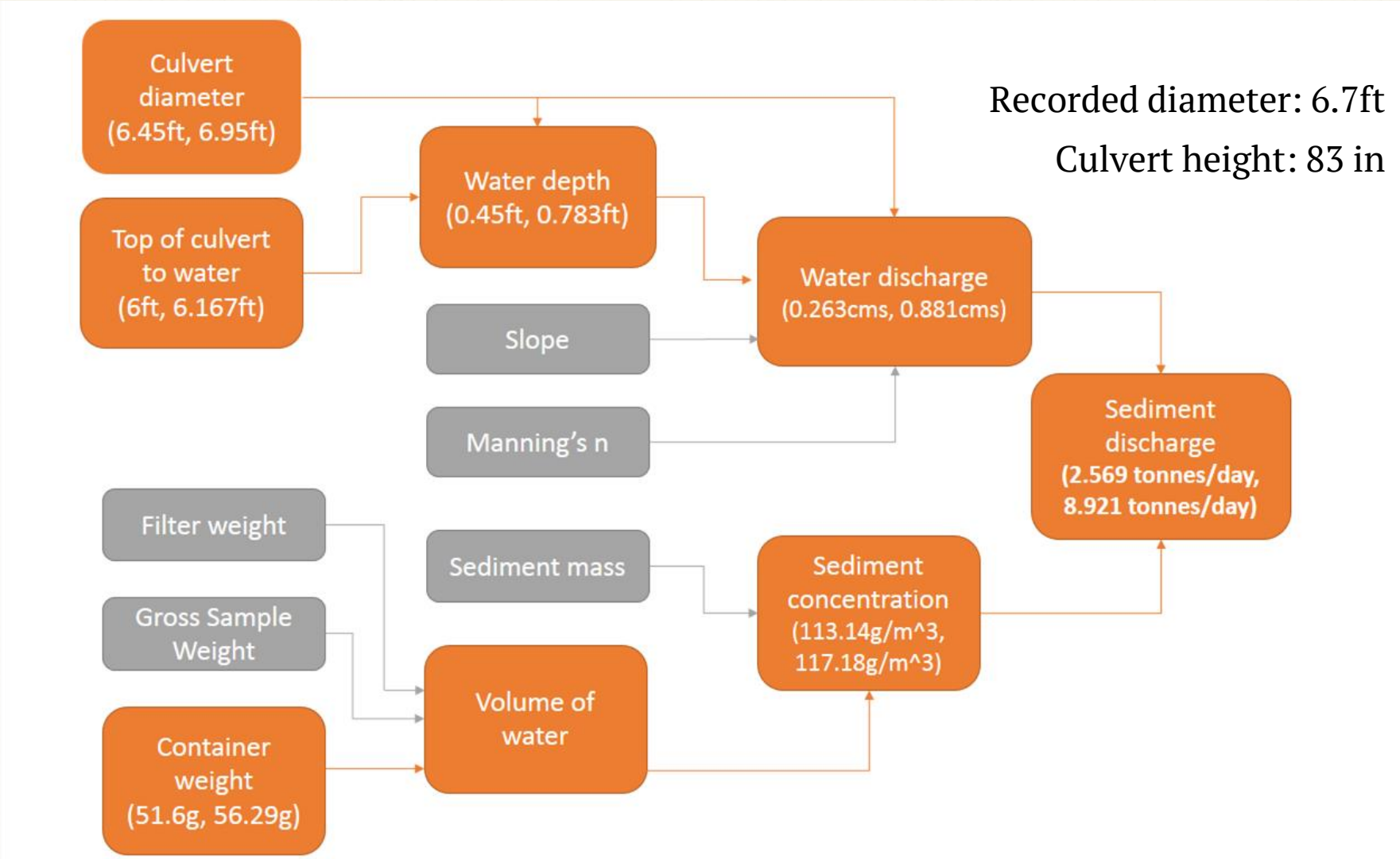
Level of uncertainty



Level of uncertainty



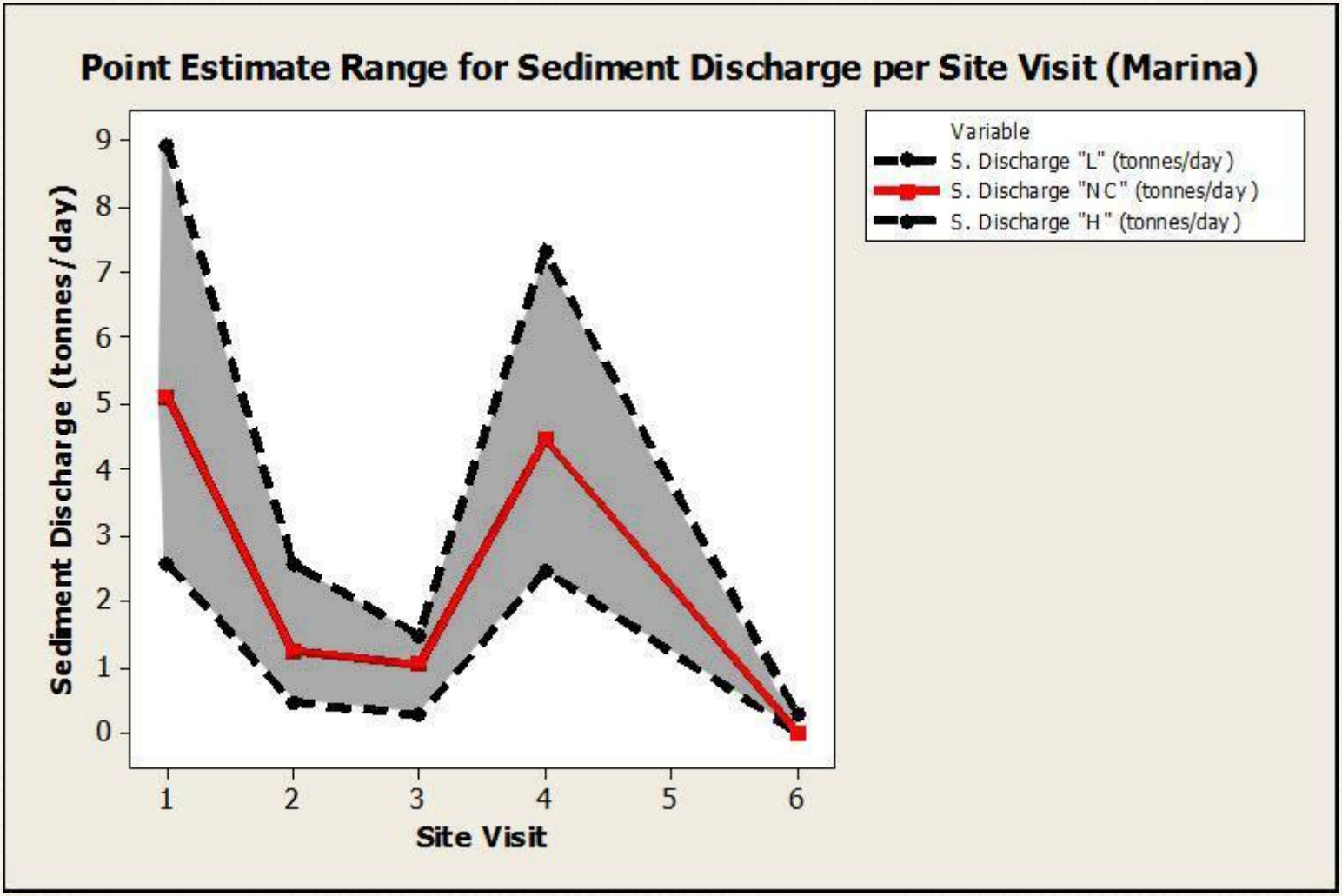
Marina Creek 1/9/16



Recorded diameter: 6.7ft

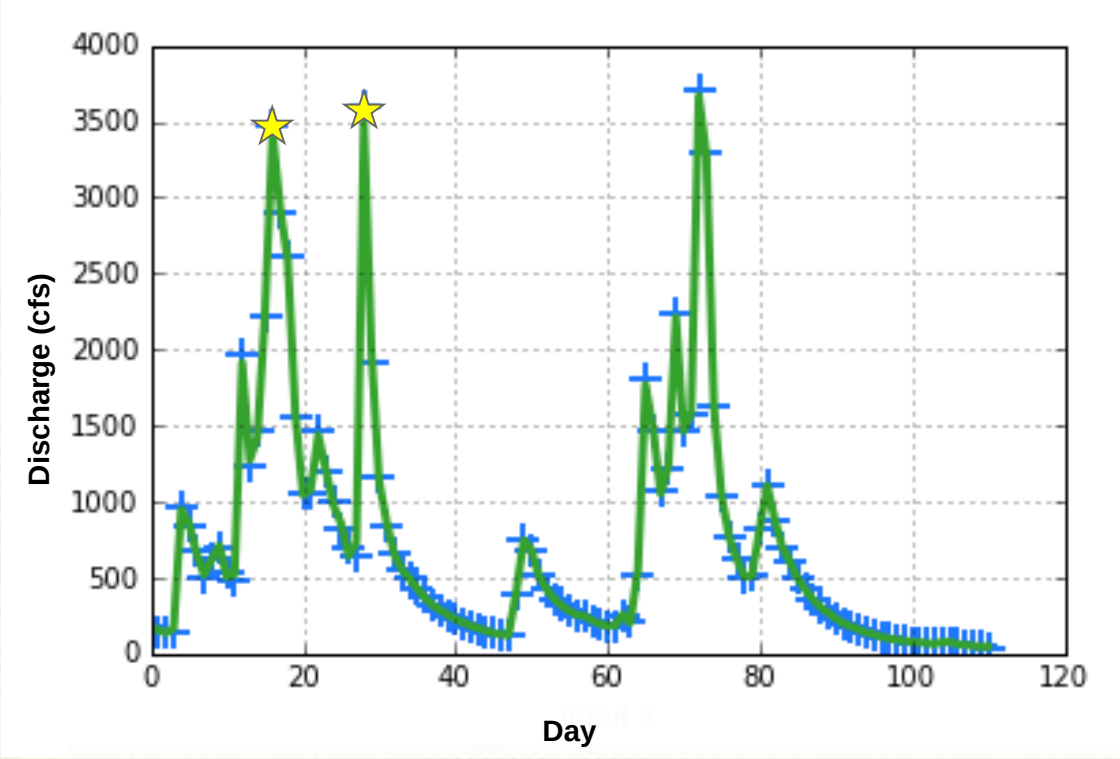
Culvert height: 83 in

Marina Creek



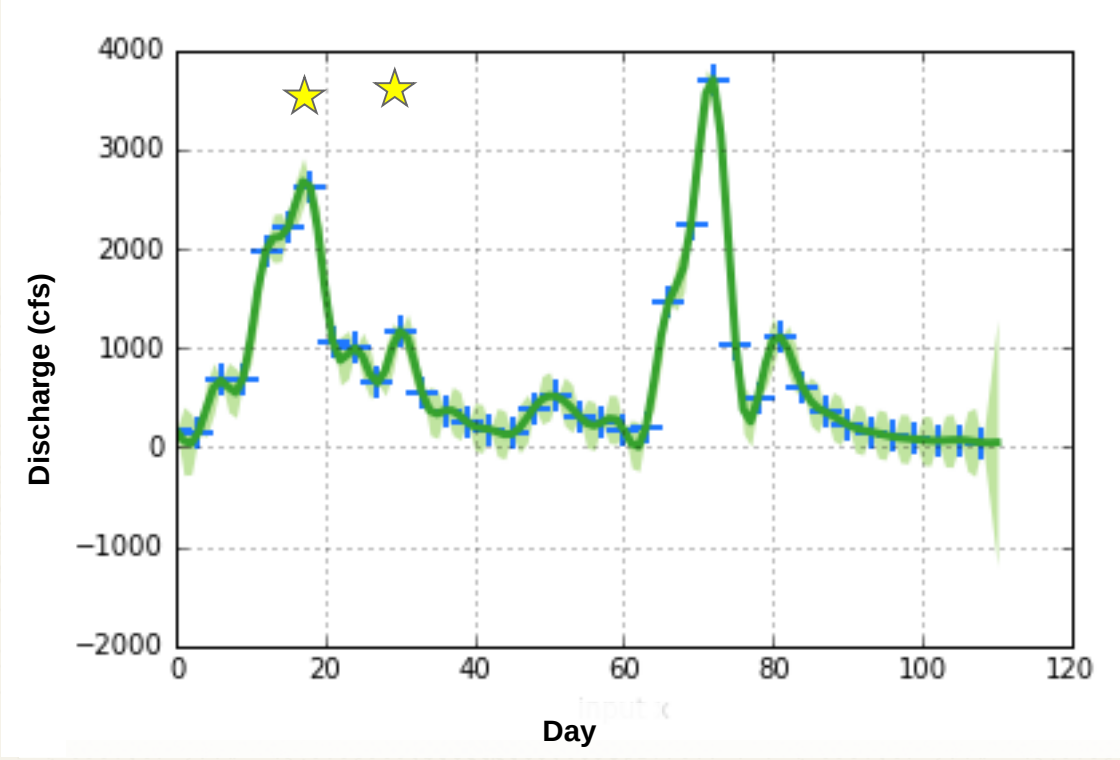
Gaussian Process Results

USGS data: daily mean



Gaussian Process Results

Every third day (37 of 111 data points)



Future collection methods

- Initial design planning
  - Parameters
  - How much data to collect
- Data collection
  - Accuracy of measurements
  - Consistent collection practices
  - Use intuition
- Quality Control

Acknowledgements

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